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FORECASTING SCIENTIFIC AND TECHNICAL PROGRESS

By

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This article seeks to analyze the relation between an increase in the level of industrial knowledge and an increase in the productivity of labor. By means of formulas and graphs, it attempts to determine that portion of the increase in production funds which should be expended on the improvement of industrial knowledge. Comparisons with similar expenditures in non-communist countries are made. The ultimate goal is the development of an analytical tool for forecasting industrial growth.

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Б б	*Б б*	B, b	С с	*С с*	S, s
В в	*В в*	V, v	Т т	*Т т*	T, t
Г г	*Г г*	G, g	У у	*У у*	U, u
Д д	*Д д*	D, d	Ф ф	*Ф ф*	F, f
Е е	*Е е*	Ye, ye; E, e*	Х х	*Х х*	Kh, kh
Ж ж	*Ж ж*	Zh, zh	Ц ц	*Ц ц*	Ts, ts
З з	*З з*	Z, z	Ч ч	*Ч ч*	Ch, ch
И и	*И и*	I, i	Ш ш	*Ш ш*	Sh, sh
Й й	*Й й*	Y, y	Щ щ	*Щ щ*	Shch, shch
К к	*К к*	K, k	Ъ ъ	*Ъ ъ*	"
Л л	*Л л*	L, l	Ы ы	*Ы ы*	Y, y
М м	*М м*	M, m	Ь ь	*Ь ь*	'
Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

* ye initially, after vowels, and after ъ, ь; e elsewhere. When written as ё in Russian, transliterate as yё or ё. The use of diacritical marks is preferred, but such marks may be omitted when expediency dictates.

FORECASTING SCIENTIFIC AND TECHNICAL PROGRESS

I. G. Kurakov

Under conditions of the contemporary scientific-technical revolution, it is impossible to plan the development of the national economy for a long-term period; one cannot organize the really effective work of the scientific-research, design, constructor, and planning organizations of the country without a timely evaluation of the prospects for the development of science and technology, and a scientifically justified forecast of the development of public production for a period of 15-20 years or more. Such a forecast is all the more important in that it serves as the basis for the planning the social and cultural development of our society.[1] The main task of such a forecast consists of the development of the most effective economic and scientific policy to provide guidance in conducting of scientific-research, planning-designing and planning work at the present time in order to obtain the results envisaged by the Program the CPSU and to strengthen the economic positions in competition with capitalist countries.

The development of such an economic and scientific policy, just as the preparation of plans for enterprises of the future (see the

[1]The need for the long-term forecast of science, technology and production has been demonstrated more and more recently in the pages of our press. See, for example, the article by A. Yefimov and V. Kirichenko. "Scientific forecast of the development of the economy of the USSR." Communist, 1967, No. 5.

article by Academician V. A. Trapeznikov, "Izvestia," 17 May 1967), is an exceptionally difficult matter. We are speaking not about the creation of any one machine or technological process, but about the development of a new, more improved type of public production of the country as a whole and about the construction of the material base of public production on the highest scientific, technological, technical and organizational basis.

It is known that even for the creation of a new design of a machine, there is a need for serious initial knowledge and, furthermore, long years of practice in the design and mastery of machines; there is a need for experiments, prototypes, tests, finishing touches, and remodeling of experimental and industrial models. In order to create more improved public production, not all factors and processes of which can be checked ahead of time on an experimental scale, there is a need for the profound knowledge of the objective regular laws of the development of public production and the most improved methods for their use in the interests of the workers. It is also necessary to look properly into the social consequences of the change of each basic factor of the development of production.

From this point of view, the preparation of more or less effective plans on the scale of the entire national economy for a year or several years ahead is an enormous achievement of our system, especially if one considers that, for the present, capitalist countries have not succeeded in long-range and even annual operational planning at the scale of the entire national economy. However, for a forecast 15-20 years ahead, knowledge which has been accumulated up to now is clearly insufficient, in particular knowledge of the factors which determine rates of growth of the national income, the productivity of work and the real incomes of the workers, and knowledge of the effect of scientific-technical progress on the development of material production. Furthermore, it is necessary to work out the methodological bases of forecasting which differ in many respects from the bases for annual and five-year planning. Thus, the necessity for a thorough theoretical development of the questions of forecasting has become urgent.

Development of the Economy of the Country and Industrial Knowledge

Of all the numerous factors which influence the general rates of development of the economy of the country the most important, unquestionably, is the growth of production knowledge; therefore, apparently, it is first necessary to study the objective ties between the "production" of knowledge and the growth in the economy of the country and to explain these ties from a theoretical point of view.[1] This question was already partially touched on in the previous works by the author (see the article "Science and the Effectiveness of Public Production." Problems of Philosophy," 1966, Nos. 5 and 10). Here we will try to deepen and develop the conclusions made previously.

Rates of development of the economy (and they are measured more accurately from the annual increase in national income) are determined, as is known, by the growth in the productivity of labor and by the attraction of an additional labor force into the sphere of material production. Under the conditions of socialist production where unemployment is absent, the increase in national income due to the attraction of an additional labor force is limited by the general increase in population and comprises no more than 1.5-2% per year; the basic increase in national income is accomplished through an increase in the productivity of labor. The entire policy of the party, beginning with the speech of V. I. Lenin in 1918 on the question of the next problems of Soviet power, has been directed therefore to the achievement of a higher productivity of labor. A Communist society with a higher standard of living than in capitalist society can be created, according to the thought of V. I. Lenin, only by the achievement of a higher productivity of labor, than in the most developed capitalist countries.

[1]We are not afraid to call the development of knowledge "production" of knowledge since now it is absolutely clear that this special type of production is a required preparatory process for all material production.

In turn, the productivity of labor depends on two basic factors: on the level of knowledge utilized in production and on the equipping of labor with the means of production, in which regard the main place in this combination belongs to knowledge since the means of production: machines, apparatuses, materials, fuel and partly raw materials, – in essence, are a material expression of knowledge and its reification. This is why the development of the industrial knowledge[1] of the workers causes an increase in national income. This connection can be measured in rubles by comparing the increase in expenditures on the education, training and retraining of personnel and on the development of new scientific and technical achievements with the increase in national income through the increase in the level of knowledge applied in production.[2] Table No. 1 presents the corresponding calculations for years 1959-1965 made from the data of the Central Statistical Administration, USSR [TsSU] concerning national income, production funds and the number of workers in the sphere of material production in the country as a whole as well as from data on expenditures on education, training of personnel, the conduct of scientific-research work and the introduction of new technology into production (see National Economy of the USSR in 1965, pages 783, 784. The level of applied knowledge and the increase in national income because of this have been calculated by us).

Thus, in 7 years more than 30 billion rubles were expended on raising the level of knowledge, and the additional increase in national income was more than 16 billion rubles.

Consequently, each ruble of expenditures on raising the level of industrial knowledge provided additional national income of 53.3

[1]Industrial knowledge includes knowledge of the consumption properties of various products and methods for their manufacture, the theoretical and practical bases of the production and the distribution of products, and of many other questions connected with material production.

[2]The dependence of the increase in national income of the country on the level of knowledge applied in production was examined in the articles indicated above in the periodical Problems of Philosophy.

Table No. 1. Return on expenditures on education, the training of personnel, and the development and introduction of new equipment.

Years	Expenditure on increasing the volume of knowledge in millions of rubles			Average level of applied knowledge in rubles per worker per year	Increase in national income through the increase in the level of knowledge in millions of rubles[1]
	on education (increase)	on research and development of scientific and technical achievements	altogether		
1959	800	1 670	2 470	1 160	3 800
1960	1 000	2 059	3 058	1 200	2 620
1961	1 400	2 393	3 793	1 220	1 340
1962	1 500	2 712	4 212	1 220	-
1963	1 500	2 912	4 412	1 210	690
1964	1 800	3 372	5 172	1 290	5 650
1965	3 100	3 837	6 937	1 320	2 180
for 7 yrs.	11 100	18 954	30 054	1 231	16 280

kopecks per year (16 ÷ 30 = 0.533). During the period 1959-1965 a reduction in the national income occurred in connection with the change to the 7-hour working day and unfavorable climatic and other conditions; therefore, the actual effectiveness of expenditures on the increase in knowledge is somewhat greater. However, even without allowing for these unfavorable factors the "return" on investments of additional knowledge in production is 1.3 times higher than the "return" on capital investments, in supplementary production funds which, for the same period, comprised about 39 kopecks per ruble of funds according to approximate calculations.

The high effectiveness of knowledge was used by the Party as the means of developing the economy of the country during all the peaceful years of the existence of the Soviet state. After temination of the

[1]Level of knowledge applied in production (У) has been determined according to formula $У = B^2/Ф$, where B is the annual output per worker engaged in material production and Ф is the production funds for this worker. The increase in national income through the value У has been determined from the formula $Hн=(B_н-B_c\sqrt{\frac{y_н}{y_c}}).P_н$, where $B_н$ B_c are the annual output, $У_н$ and $У_c$ are the level of knowledge in the new and preceding periods, and $P_н$ is the number of workers in the new period.

Civil War, raising the level of knowledge of the workers became one of the basic tasks of the country. Expenditures for these purposes reached 17-18% of the national income produced. Subsequently, this problem was always considered paramount.

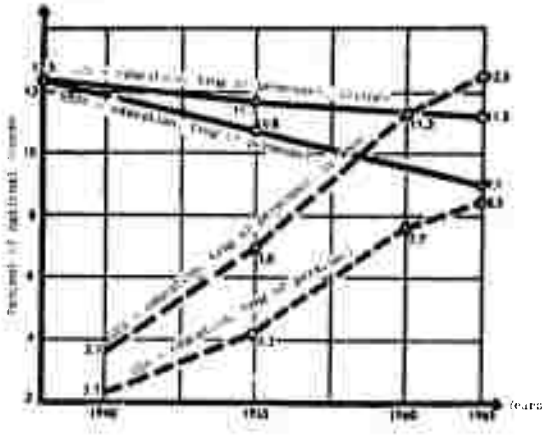
The rates of growth in national income in the USSR during the first five-year plans, unprecedented for capitalist countries and which reached 15-16% per year, are explained to a considerable extent by the circumstance that we succeeded in eliminating the illiteracy of the workers in exceptionally short time spans and in raising quickly the general educational and special level of their knowledge. Without this, in no way could we effectively create, build, and operate new enterprises and production.

The experience of the development of economy of our country by raising to the maximum the level of knowledge of the workers as the main factor of development also began to be adopted in recent years by capitalist countries in which the development of this aspect of activity was greatly limited to payment for training in secondary and higher educational institutions and to financing expenditures on the development and introduction of new equipment, primarily through the means of private industrialists.

Now the greater part of the capitalist countries have expanded considerably the opportunities for obtaining an education through government grants, and the financing of more than half of the scientific research and development is performed at the expense of the state budget. Diagram No. 1 shows the approximate dynamics of the growth of expenditures on the education and training of personnel and on science in the USSR and the United States, which testifies to the changes which are taking place in this area in the two largest countries of the world.

Up to 1950 the advantage of the USSR over the United States with respect to the share income being spent on the education and training of personnel was very substantial, and this circumstance explained to a certain extent the higher rates of growth in the

Diagram No. 1.



national income in our country. After 1950, and especially after 1960, the relative difference in expenditures on the development of knowledge was reduced more and more and, accordingly, the difference in rates of annual growth in the national income was reduced. In 1960-1965, the rates of growth in the national produce in the United States rose to 4.5% as against 2.5% in 1950-1958, while they comprised about 6.6% for us (see National Economy of the USSR in 1965, page 86).

Since 1965, U. S. expenditures on the education and training of personnel have continued to grow rapidly, just as expenditures on scientific research and development have grown. According to forecasts by several economists of the United States, by 1980 they may reach about 20% of the national income. Seemingly, such an increase in expenditures for these purposes should also be assured in our country because the modern era of the scientific and technical revolution by the actual predominant power in public production is the country which possesses personnel with the greatest industrial knowledge. It is no secret that the post-war period of world development is characterized by a special form of colonialism (it can be called technological colonialism), since England, France, the Federal Republic of Germany [FRG], Japan and Italy could develop their economy predominantly by purchasing scientific and technical achievements in the United States, which, naturally, led to tying these countries economically to the United States.

The large and ever increasing share of the national income being spent on the production of knowledge causes the necessity to introduce into practice the accounting for the general volume of industrial knowledge used in the country and the determination of the effectiveness of this knowledge, similar to what is presently done with respect to production funds. As yet, there is no such accounting, and the development of the appropriate procedure is greatly hampered because of the vagueness of many of its theoretical fundamentals.

Nevertheless, for a beginning we are daring to outline the following ways for developing the procedure for this accounting.

The final results of the utilization of industrial knowledge can be measured by the amount of output of one worker calculated with respect to national income and related to 1 ruble of specific production funds (of basic production funds and working capital per ruble of national income). This quantity expresses the effect of knowledge most fully, since the higher the level of applied industrial knowledge, the higher the output of one worker and the less the specific production funds (see Problems of Philosophy, 1966, Nos. 5 and 10).

This relation can also be justified in the following manner: knowledge is, perhaps, the sole means of raising the degree of use of industrial resources. The greater the knowledge, the higher the degree of utilization of live and public labor and of all natural resources. The degree of utilization of live labor is measured by its productivity, and of public labor – by the "return" of production funds; therefore, the total degree of utilization can be determined by the formula $y = B \cdot \frac{B}{\Phi}$, where B is the productivity of labor, Φ is the capital supply for labor and B/Φ is the "return" of production funds. Since the specific production funds $H = \Phi/B$, $y = B^2/\Phi = B/H$.

At a scale of the entire national economy, the value B equals the national income; therefore, the general level of knowledge used in production can be determined by dividing the actual national income by the average specific production funds for the national economy. Table No. 2 presents the results of such an accounting for the USSR and the United States, in which respect since we do not have reliable data about the national income and especially about production funds in the United States, the data on the United States should be considered especially approximate.

Table No. 2. The general level of knowledge used in production in the USSR and the United States in 1959-1965.[1]

Years	USSR			USA		
	national income in billions of rubles (B)	specific production funds in rubles per ruble (K)	general level of knowledge used (B/K) in rubles	national income in billions of dollars	specific production funds in dollars per dollar	general level of knowledge used in dollars
1959	137,3	1,88	72,7	no data	no data	no data
1960	147,9	1,88	78,8	338,0	1,73	195,5
1961	157,9	1,92	82,3	346,0	1,73	200,0
1962	166,9	2,00	83,5	361,6	1,73	212,0
1963	173,7	2,08	83,5	381,0	1,72	222,0
1964	199,8	2,09	91,2	402,0	1,69	238,0
1965	203,4	2,13	95,0	433,0	1,71	252,0

The table has the purpose of showing how we can measure the results of the use of knowledge on a country-wide scale. It is not intended for comparisons of the situation in the two countries.

We will try to show below the great economic and social significance of the determination of the general level and rates of growth of knowledge used in production.

[1]Basic data on the USSR and national income for the United States have been taken from the collection of the TsSU USSR National Economy of the USSR in 1965, pages 589, 64, 761, 86. Specific production funds for the United States have been determined from the UN monthly publication Monthly Bulletin of Statistics.

Knowledge, Productivity of Labor, and the Real Income of the Workers

We will now examine the social aspect of the development of knowledge and its reflection on the level of payment for labor. For this, it is necessary to disclose the basic factors influencing the real income of the workers and the interaction of these factors. Which objective factors influence the incomes of the workers of material production?

In essence, there are only two of them: productivity of labor, which determines the degree of utilization of live labor, and effectiveness, the "return" of production funds, which shows the degree of utilization of materialized labor. All other factors (natural conditions, quality of production and its use value, rates of increase in production and others) are second order dependences which are considered in the first two.

Why do we consider it necessary to consider the effect of two factors on the productivity of labor rather than one as is customarily accepted? Because the productivity of labor, to a certain degree, depends on its capital supply – it depends on the amount of materialized labor per worker. If we discard this factor, then the operator of any complex and expensive machine would have the right to demand excessively high wages on the ground that he produces work not comparable with the capabilities of a worker not equipped with equipment. The operator of a 15-cubic meter excavator, for example, which produces 5 thousand cubic meters of earth work per shift, could demand payment of 500 rubles per shift for a brigade of 5 men, on the average of 100 rubles per man. But such an output by this operator is caused by the participation of many other workers in production (machine builders, metallurgists, power engineers and others), the labor of whom has been materialized in the excavator itself and in the energy which it consumes. And if this labor is utilized poorly, the operator himself must answer first, and must answer, of course, materially. Otherwise, the struggle for an increase in the productivity of labor would lead to a race for an

excessively large quantity of technological equipment, production areas, raw materials and stocks, and resources, the creation of which "would eat up" a considerable part of the output, which actually often occurs in our national economy. Thus, several collective farms and state farms acquire an excessive quantity of agricultural machines which they are not able to use rationally, as a result of which the output per manhour is reduced. Coal miners require complex underground units which, however, are only 15-20% utilized. Railway workers prefer working with electric locomotives and not with diesels, although with approximately the same power the former requires almost twice as much capital investment. Consideration of the second factor, thus, is an objective necessity.

Just how should none combine output and "return" in one general indicator which determines the actual contribution of one worker to public production?

For this, one ought to use the formula $B = \sqrt{У \cdot Ф}$ (see Problems of Philosophy, 1966, Nos. 5 and 10). It shows that output (B) is created because of two factors. Factor Ф considers the effect of materialized labor, and factor У – the effect of live labor. But since $У = B \cdot \frac{B}{Ф}$, the wage which corresponds to the contribution of live labor to production should be equal to the output multiplied by the "return" of production funds. (The output of one worker is newly materialized labor and the "return" shows the degree to which the materialized labor is used in the given production.) Consequently, $Зр = B \cdot \frac{B}{Ф} = У$, i.e., the wage level (Зр) and the level of knowledge used in production (У) should coincide.

Every worker engaged in public production, thus, has the right to obtain from society as much material and other good things in life as he contributes to this production of knowledge. Her, it is opportune to recall the famous phrase of the English Seventeenth Century philosopher, Francis Bacon: "Man is capable to the extent of his knowledge." To these words we could add "and his desire to

use it." Let us see if this important conclusion corresponds to statistical data.

In 1965, the average level of knowledge of one worker used in production in the USSR, in current prices, was 1060 rubles, and the average wage – 1080 rubles. Approximately the same correlation between average level of knowledge used and average wage also occurred in previous years. In 1960, the average annual wage was 1.2 times lower than in 1965, and the average level of applied knowledge was also 1.2 times lower (see National Economy of the USSR in 1965, page 567).

Thus, in a socialist national economy in which the crisis of overproduction is absent, the wage is determined by the knowledge used in production. And probably, by nothing else. But since this knowledge can be increased primarily by the development of research and development, intensification of the training of personnel, and stimulation of the utilization of knowledge, a direct link follows between the production of knowledge and the creation of the material and technical base of communism. In order to create the material and technical base of communism, it is first necessary to raise the level of industrial knowledge of the workers and to apply effective stimuli for its maximum utilization. Priority belongs to knowledge, since without a high level of knowledge a high level of technology cannot be attained. Thus, besides the material and technical base it is also necessary to create the corresponding scientific base for communism.

Using the formula $Зр = В \cdot \frac{В}{Ф}$, let us consider the question of the rates of growth in the productivity of labor and wages. Two cases are possible here: the first, and the one encountered most frequently, is when output B increases, and "return" B/Ф is reduced, and second – when output and "return" increase. In the first case, the rates of growth in wages will lag behind the rates of growth of the productivity of labor, while in the second case they will outstrip the rates of growth of the productivity of labor. Let us

assume, for example, that the annual output of one worker in the sphere of production grew from 2470 to 3170 rubles, and the "return' decreased from 0.465 to 0.455 rubles; then the annual wage will increase from 1149 to 1432 rubles. The productivity of labor increased 3170:2470 = 1.28 times, and wages – only 1432:1149 = 1.24 times. However, if the "return" is not reduced but is increased, for example, from 0.465 to 0.475 rubles per ruble of production funds, then wages will increase to 1506 rubles, 1506:1149 = 1.3 times. *Consequently, the main reason for the lag in wages behind the productivity of labor consists of the lowering of the economic effectiveness of production funds.*

This important proposition is confirmed graphically by statistical data about the development of our country. In 1950-1958, in comparison with 1950, the "return" of production funds increased from 0.546 to 0.568 rubles per ruble of funds, and retail commodity circulation per worker of material production increased, allowing for a reduction in prices, from 705 to 1430 rubles with an increase in annual output from 1026 to 2027 rubles.[1] Productivity of labor increased 2027:1026 = 1.97 times, and real wages – 1430:705 = 2.03 times, i.e., it increased more than the productivity of labor. This phenomenon is explained by the fact that with an increase in the rates of scientific and technical progress the "return" of production funds increases due to improvement in the degree of utilization of industrial resources. In connection with this, a real possibility appears for the outstripping of the rates of growth in wages in comparison with rates of growth of productivity of labor. The higher the rates of scientific and technical progress, the greater should this outstripping be. The actual degree of outstripping shows how great the rates of scientific and technical progress are. If a lagging takes place instead of outstripping, then this is a sure sign of insufficiency in the introduction of scientific and technical achievements into the national economy.

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[1]Calculation of the indicated figures has been performed from the basic data published in the annual National Economy of the USSR in 1965, pages 64, 65, 99, 590, 556, 627, 652.

Of course, we have in mind the economically sound growth in wages, and not inflation.

In considering the history of capitalist production from this point of view, one can note the enormous significance of the indicator of the "return" of production funds for the economics of public production in all capitalist countries. The long period of development of these countries is characterized by the maintenance of the "return" at approximately the very same level, in which respect the strongest countries used colonialism for this goal as a method of increasing the degree of effectiveness of production funds. Subsequent to the Second World War scientific and technical progress is being used for this purpose. Using the development and introduction of more and more improved types of output and methods for its production, not only has a reduction in the effectiveness of production funds been stopped but in many instances it has even been increased. Therefore, during the last 10 years in several western countries an outstripping of the rates of growth of the productivity of labor by rates of growth of wages is noted.

For summing up everything that has been said about the interrelations between knowledge, productivity of labor and wages, the conclusion may be drawn about the need for a considerable improvement in the economic policy for the development of socialist production. It is now necessary to concentrate main attention not on the simple expansion of production capacities and funds but on scientific and technical progress and on increasing the degree of utilization of industrial resources as the most effective method of creating the material and technical base of communism and the rapid improvement of the social conditions of the workers.

Rates of Growth of National Income

The most difficult and important problem of forecasting is the determination of the rates of annual growth of the national income of the country, on the basis of which new production capital investments and expenditures on residential construction, education,

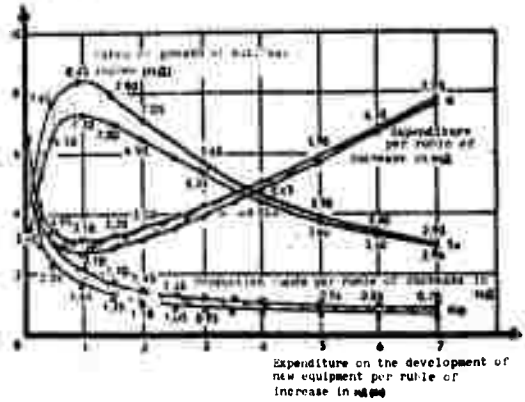
science, public health and others are established. The method of establishing the rates of growth of this income which is generally accepted at the present is the extrapolation of the previous rates actually reached to following years. Practice, however, shows the groundlessness of this method which does not consider the extremely important changes in the factors which determine the rates of growth and, especially, those of them which are connected with scientific and technical progress. Below, an attempt is made to establish several theoretical foundations for a stricter scientific approach to the solution of this problem.

The rates of growth of national income are determined basically by the share of his income alloted for the development of public production and by the effectiveness of new capital expenditure. If, for example, from every ruble of national income obtained 22.5 kopecks are alloted to the development of production, and to obtain 1 ruble of additional national income 3.2 rubles of capital investments in new production funds and new knowledge are required, then the rates of annual growth of national income comprise (0.225:3.2) × × 100% = 7.0%. The increase in the effectiveness of capital investments or the share of the national income allotted for the development of public production increases the rates of growth and, conversely, a reduction in effectiveness and the corresponding share of income reduces these rates.

However, it should be kept in mind that an increase in the share of national income allotted to the development of production reduces accordingly the share allotted for consumption; therefore, this method of development of the economy is greatly limited. The main method of increasing the rates is assuring the high effectiveness of new capital expenditures. Diagram No. 2 shows the influence of this effectiveness on the rates of growth of the national income and the basic factors which determine the effectiveness of new production expenditures.

As can be seen from this diagram, new production capital investments are composed of two parts: expenditures on production

Diagram No. 2.



Expenditure on the development of new equipment per ruble of increase in

funds (basic and working) and expenditures on the development of new industrial knowledge, more accurately on the research, development, and introduction of technical achievements. The connection between them is inverse: the less the production funds per ruble of additional national income, the greater the expenditure on the research, development, and introduction of scientific and technical measures. The overall expenditures on the development of production therefore are optimum, the exceeding or lowering of which will lead to a loss in the rates of growth of the national income.[1]

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[1]Diagram No. 2 has been constructed in the following manner: production funds per ruble of national income $H\phi = \Phi/B$, but $B = \sqrt{y \cdot \Phi}$ (see Problems of Philosophy, 1966, Nos. 5 and 10), therefore $K\phi = \sqrt{\frac{\Phi}{y}}$; hence $y = \Phi/H_\phi^2$, and the expenditure on increasing y, referred to one ruble of national income, $K_T = \frac{e \cdot y}{B} = \frac{e \cdot \Phi}{B \cdot K_\phi^2}$, where e is expenditure on increasing the magnitude of y per ruble. In 1965, for the USSR e = 1.85, Φ = 6000 rubles and B = 2570 rubles; therefore $K_T = \frac{1 \cdot 35}{K_\phi^2}$. For the United States, with a supply of capital of 6000 dollars, e = 1.85 and B = 4000 dollars; therefore $H_T = 2.75/H_\phi^2$. Using this formula, the values of $H\phi$, the sum of $(H_T + H\phi)$, and the rates of growth of national income (T_H) have been found for two variants (curves 1 and 2). In this case, the share of the national income allotted to the development of production has been taken as 22.5%, and the rates of growth of the national income have been found from the formula $T_H = \frac{0{,}225}{K_T + K\phi}$.

Diagram No. 2 shows that the decisive factor for rates of growth of the national income are expenditures on knowledge (Нт) (the development of scientific and technical achievements, their mastery and training cadres of specialists). The increase in expenditures on knowledge, as a rule, leads to a lowering of expenditures on production funds; therefore, one whould not consider expenditures on science and the training of personnel as some kind of overhead expenses of society, as they are still considered now and then by financiers and statisticians. Expenditures on the development of knowledge are the basic factor in the growth of public production, and the skill of the planning worker consists of finding the corresponding optimum for each specific case.

The increase in the general effectiveness of scientific-research and planning-design work depends to a certain extent on the relation between capital investments in production funds and capital investments on the development of scientific and technical achievements. The most advantageous correlation, as can be seen from Diagram No. 2, occurs when about 47.5 kopecks are allotted to science for every ruble of increase in production funds. In the USSR this correlation does not hold up for the present and this, according to approximate calculations, reduces the effectiveness of scientific-research work at least into 1.6-fold.

However, in order to improve the correlation between expenditures on the development of new technical achievements and expenditures on expanding production funds, it is necessary to strengthen planning-design and engineering developments since the capacities of the subdivisions engaged in this work are clearly insufficient.

Leading experience shows that best results can be attained when there are 2.5-3.0 rubles of expenditures on planning-design and engineering development per ruble of expenditures on research. Otherwise, much scientific-research work remains unused. Furthermore, the insufficient capacity of existing planning-design organizations causes the necessity to build new units on the base of

those available and not of new equipment, and this reduces greatly the rates of technical progress. The lagging of engineering organizations engaged in production with the mastering of scientific and technical achievements and the training of appropriate personnel increases the periods for the mastering of designed capacities. Approximately such a situation has been presently created in our country, as a result of which it is urgently necessary to transfer a part of the specialists engaged in operation and even in research to planning-design and engineering work. It is not simple to accomplish such a measure. It will require a long time to train new personnel and, therefore, it should be provided for in forecasts. Judging from the experience of other countries, the most advantageous correlations in expenditures on research and refining measures will be the following: on scientific-research work, about 10% of the increase in production funds, and on planning-design and engineering development of proposals, about 25-30% of the increase in production funds.

The second method of increasing the effectivenesses of scientific-research and planning-design development is the improvement of the knowledge of the scientists and specialists and equipping them with a sufficient quantity of laboratory and experimental equipment. The output of one scientific worker – a planner and a constructor, just as of any other worker engaged in material production, depends on the level of knowledge which he uses and on the state of the material equipping of his work site. In the USSR and the United States, according to our approximate calculations, the average level of knowledge utilized by one scientific worker is estimated to be approximately the same, 12.5 thousand rubles. The extent of the outfitting of one scientific worker with working space, laboratory equipment, and experimental units is about 6.0 thousand rubles in the USSR, and about 15 thousand rubles in the United States. As a consequence, the results of the work of one of our scientific workers is lower for the present.

In addition to the increase in the effectiveness of research and development and the improvement of the correlation between capital investments for an increase in production funds and for the development of scientific and technical achievements, there is a great influence on the rates of the growth of national income by the distribution of capital investments to increase the degree of utilization of industrial resources (to increase the value У) and to increase the capital supply of labor. Capital investments which are necessary for the increase in national income, $H = H_T + H_\Phi = \Phi/B$, but $B = \sqrt{У \cdot \Phi}$; therefore, $K = \sqrt{\frac{\Phi}{У}}$. From this simple relation it can be seen that when the growth in the value У is less than the growth in the value Ф, then H increases and the rates of growth of the national income are reduced. Consequently, it is necessary to develop the national economy in such a way that the growth in the level of utilization of production resources always outstrips the growth in the capital supply of labor.

The social significance of this circumstance can be presented in the following manner: mechanization and automation of the work directly connected with increasing its capital supply always reduce somewhat the rates of development of the economy of the country and the real incomes of the workers (because the "return" of production funds is lowered); therefore, the degree of their growth is directly connected with raising the quality of the products and improving methods of production. Improvement of the quality of the products and the methods of their production should always outstrip the increase in the mechanization and automation of labor. An exception can be allowed only in special cases, for example, when a reduction in the "return" of production funds in a given production unit is compensated by an increase in this "return" in other production units or when this is caused by defense circumstances.

The Structure of Public Production and the Quality and Quantity of Output Produced

In addition to the establishment of rates of growth of the national income, an extremely important problem of forecasting is the determination of the optimum correlations between the development of the economy by increasing the quantity of the product manufactured in the country and development by increasing the use value of the products and reducing specific expenditures this means. Experience shows that excessive enthusiasm for growth in the physical volumes of production will inflict great losses on the national economy (just as excessive enthusiasm for raising the quality of the products); therefore, in forecasting the development of the economy of the country, it is necessary to find the optimum variant of the correlation of these two factors. Further, the structure of public production is changed with an increase in the use value of the products; consequently, the quality, quantity and structure of public production are interconnected with each other. What is the nature of these connections which should be considered in forecasting the development of the economy? This question can be answered in the following manner.

It is better to express structure of public production by the share of the national income which belongs to the given production, in other words, by the proportion of working time which is allotted by society to satisfy a given need of the workers. This proportion depends to a certain extent on the use value, on the cost of the output. The value of the output, in turn, can be measured by its specific expenditure per ruble of national income as the final result of production. For example, the expenditure of crude steel per ruble of national income produced in 1958 was 0.43 kg, and 1965 – 0.45 kg; consequently, the value of steel was reduced by almost 5% during this period. Apparently, with an increase in the output of steel the degree of its use worsened and the share of the national income spent on the production of steel increased. If the cost of the given output per worker engaged in material production is expressed by the values M and the annual output of this worker –

by B, then the proportion of this output П in the national income will equal the ratio between them — П = M:B. The cost of steel production per worker in the USSR, in 1965, for example, was 160 rubles and the annual output of this worker with respect to national income produced in 1958 prices was 2800 rubles; therefore, the proposition of the ferrous metal industry in the national income was (160:2800) in 1965. 100% = 5.75% as against 5.50% in 1958.

When the cost of output produced per man increases to the same degree as the output per man, then the structure of the national income does not change; if, however, the output increases more rapidly, then the proportion of this output in the overall volume of production is reduced. Scientific and technical progress reduces the proportion of the national income belonging to one or another product previously produced, since it leads either to a reduction in the cost of production of the output or to a lowering of its specific expenditures. Forecasting should therefore envision a considerable reduction in the proportion of the output presently produced and the organization of the production of new types of products or of new services to utilize the labor resources which have been released. A typical illustration of what has been said can be provided by Table No. 3 which pertains to the production of agricultural products in developed capitalist countries.

Table No. 3. Proportion of agricultural products in the gross national product of a country (in percent).[1]

	1950	1960	1965
United States	7.1	3.9	3.3
England	4.4	4.3	4.4
France	11.7	9.5	6.0
FRG	6.8	5.4	4.4
Italy	22.2	16.4	14.1
Netherlands	10.1	9.0	7.0
Belgium	7.9	7.9	6.2

[1] See "Financial Analyst's Journal." USA, March-April 1967, page 30.

The rapid scientific and technical progress in agriculture, which is expressed by the use of chemical fertilizers and toxic chemicals, the development of the mechanization and industrialization of production, and the sharp improvement in the use of ready-made products, as can be seen from the table, permitted a considerable reduction in the proportion of this branch of the national economy in the national product.

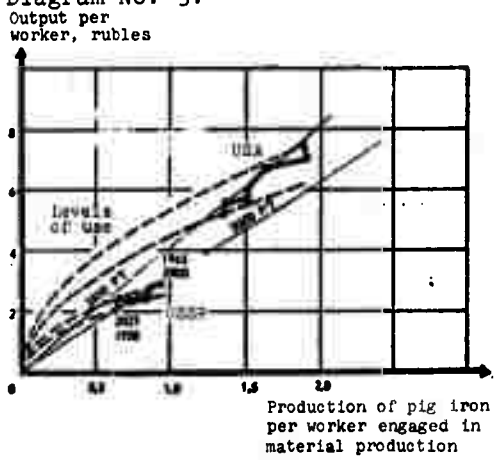
This problem can be solved in our country by means of the maximum increase in the productivity of labor and the effectiveness of production funds and, through this, a reduction in the number of agricultural workers to 5-6% of the total number of workers in material production. At the present time, the productivity of labor in agriculture of the countries presented in the table is approximately 2-2.6 times lower than in industry; however, scientific and technical progress is rapidly reducing this difference, and it can be expected that in the next 15-25 years it will be completely eliminated. This should also be envisaged in forecasts.

The separation of agriculture from industry, from the economic point of view, was caused by the relatively small size of one production unit (one farmstead, one farm), by the low productivity of agricultural crops, insufficient mechanizations of work, and the seasonal nature of production. Now the possibility to climinate these obstacles and to bring the productivity of labor in agriculture to the level of the productivity of labor in industry has appeared. Our state farms and collective farms represent big production units by their size which are not at all comparable in this respect with farms. Chemistry is providing the opportunity to solve the problem of increasing productivity, and continuous electrification – the problem of the mechanization of labor. Thus, all prerequisites have been created for the solution of a social problem of exceptional significance: for the elimination of contrasts between city and village and for the conclusion of an entire era of the development of human society which is linked to the separation of agricultural production from industrial production.

A real possibility is being created to resettle agricultural workers in the cities, since the proportion of these individuals in the overall labor resources of the country will comprise only about 4-5% and modern transport capabilities will eliminate losses in time in trasnporting people from the city to their place of work.

Scientific and technical progress in the field of improving the quality of output and the basic factors which determine the economic significance of this improvement can be established if we analyze the diagram (No. 3), which we have constructed and which shows the increase in the output of one worker engaged in the sphere of material production, depending on the volumes of production of pig iron per one such worker.

Diagram No. 3.



As can be seen from this diagram, with an increase in production of pig iron per worker its value per ton, expressed in national income, is reduced if in this case the degree of utilization of pig iron is not improved. For this not to occur, in the USSR and the United States the degree of utilization of pig iron is being raised systematically; however, with us, this process is proceeding more slowly. The diagram shows that the national-economic value of pig iron smelted in the USSR would be higher than the existing level by approximately 1.8 times, if the degree of its utilization

corresponded to the level reached in the United States.[1] The specific expenditures of pig iron would be decreased proportionally. With the same volumes of its production, more machines, equipment and consumer articles could be produced.

Diagram No. 3 also shows that an increase in the volume of production of products must be accompanied by an increase in the degree of their utilization by raising the quality and variety as well as by improving the technology of application. If the quality of the output and the technology of its application are not improved, the physical growth is the production of the output will be accompanied only by an increase in its specific expenditures and, accordingly, by a lowering of the effectiveness of production funds. This can be reflected only negatively on the growth of the material well-being of the workers – a circumstance which for the present is evidently insufficiently considered by our planning organizations.

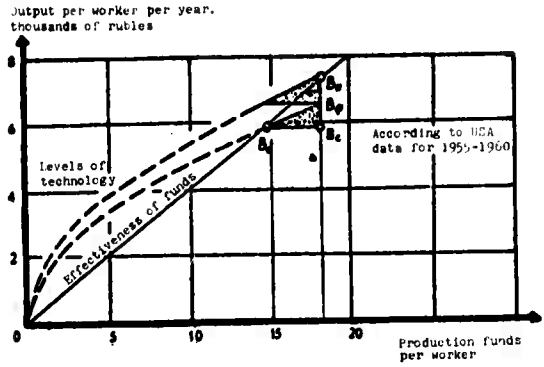
Diagram No. 4 shows that to maintain the effectiveness of use of production funds, the growth in output due to an increase in the physical volumes of production per worker should be approximately equal to the growth in output due to an increase in the degree of use of the output.

Returning to everything presented above, several conclusions may be drawn relative to the competition of the two systems under conditions of the contemporary scientific and technical revolution.

In competition with socialism, capitalism began to make wider use of the mightiest means for the development of the public production – knowledge and science. If, formerly the basic method of competition was the accretion of production funds and the maximum increase in production capital, now the main means is the rapid

[1]The comparison with the United States, in this case extremely necessary, has been made under the condition that 1 dollar equals 0.76 rubles, as was accepted by the TsSU USSR in 1965 (see National Economy of the USSR in 1965, pages 87 and 591).

Diagram No. 4.



increase in industrial knowledge. This includes a new special feature of competition which obliges us to take appropriate effective countermeasures. In the new situation, socialism has by no means lost its enormous advantages over capitalism. On the contrary, our capabilities in the competition are increasing considerably. We have more than a twofold advantage in the number of graduate engineers engaged in the national economy and a fourfold advantage in the output of young specialists, which permits creating a considerable superiority in the scientific and technical base of the national economy in short spaces of time. However, for this it is necessary to conduct a number of changes in the structure of production and in the distribution of capital investments for modernization, new construction, and the development of technical achievements. Specifically, our expenditures on the research and development of new technical achievements for the civil branches of the national economy in the next 10-12 years should increase annually, according to approximate calculations, by at least 18-20%. Only in this instance can we create a society with the most advanced productivity of labor in the world and defeat capitalism once and for all in the field of production.

Nor has socialism lost its advantages in the field of utilization of the labor force and the growth in national income. The absence of unemployment in our country and the socialization of

the means of production permit allotting to the development of production 9-10% more of the national income than in the advanced capitalist countries and this, all things being equal, increases the rates of growth of national income by a minimum of 4-5%.